CEBAF EXPERIMENT 91-013

The Energy Dependence of Nucleon Propagation in Nuclei as Measured in the (e,e'p) Reaction

The propagation of nucleons through the nuclear medium is a fundamental characteristic of the nuclear many body problem. There remains considerable uncertainty in how to evaluate the propagation of nucleons participating in nuclear reactions. For medium energy, 100-500 MeV, protons, there are substantial variations between the "proton mean free paths" extracted from various parameterizations of the proton optical potential and from calculations based on the free nucleon-nucleon cross sections. Furthermore, especially in experiments at higher energies, it is often not possible to resolve protons which are coherently diffracted by the nucleus from those which undergo small angle or small energy loss interactions. For these experiments, a more macroscopic examination of nucleon propagation in nuclei is necessary.

Quasifree electron-proton scattering provides an excellent tool to study nucleon propagation effects. The electron-nucleon vertex is well understood on shell, so that these reactions can be viewed as tagging a source of protons emerging from throughout the nuclear volume. The electron kinematics will be fixed to restrict the scattered electron energies to be close to the quasifree peak at which the reaction mechanism has a large single nucleon component. The integrated quasifree coincidence yield (integrated over missing-energy and recoil momentum ranges corresponding to single-particle knockout) provides a measure of the macroscopic attenuation, averaged over the binding energies of single-particle states and the angular range of the quasifree angular correlation (pf/|q| where pf ~ 250 MeV is the Fermi momentum of the nucleus and |q| is the magnitude of the three momentum transfer).

A first measurement of this type was performed at the MIT Bates Laboratory for proton kinetic energies, T_p ~ 180 MeV. A significant new development in understanding these data is the observation by Benhar et al.[1] and Pandharipande and Pieper[2] that the calculations of the transmission in $(e,e'p)$ reactions are sensitive to the two-body correlations in the nuclear medium. In this experiment, these measurements will be extended from T_p=400 MeV to 2000 MeV (Q^2 of 0.76, 1.3, 1.9 and 3.8 $(\mathrm{GeV/c})^2$). Rosenbluth separations of the longitudinal and transverse yield will be performed at T_p=400 and 1000 MeV to verify the reaction mechanism. While the longitudinal response is expected to be determined by the single-nucleon spectral function, the transverse response will certainly contain some contributions from meson exchange currents or other multi-nucleon mechanisms. At the highest energy, nucleon propagation may reflect the underlying quantum-chromodynamic properties of the strong interaction by revealing increased proton transmission.

The data sample proposed here would provide a single body of systematic data over most of the proton energy range important at CEBAF, TRIUMF and LAMPF. This experiment is uniquely suited for CEBAF's facilities.

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[1] O. Benhar, A. Fabrocini,S. Fantoni,V.R. Pandharipande and I. Sick, Phys. Rev. Lett. 69, 881 (1992)

[2] V.R. Pandharipande and S.C. Pieper, Phys. Rev.C 45, 471(1992)